

What is claimed is:

1. An interferometer system for a one-way QKD system, comprising:
  - a first QKD station that emits a quantum signal and a control signal and having a first interferometer loop;
  - a second QKD station optically coupled to the first QKD station via an optical fiber link and having a second interferometer loop a detection stage operably coupled to an output of the interferometer loop, wherein the second interferometer loop has an arm with a phase shifter;
  - a polarization control stage arranged immediately upstream of the second QKD station;
  - a controller coupled to the detection stage and the phase shifter; and
  - wherein the quantum signal and the control signal traverse the same path through the first interferometer loop, the optical fiber link, the polarization control stage and the second interferometer loop, and wherein the control signal is detected by the detection stage and is used by the controller to actively adjust the phase shifter to perform phase-stabilization of the second interferometer loop.
2. The system of claim 1, wherein the control signal and the quantum signal have the same wavelength.
3. A method of stabilizing a QKD system having a first interferometer loop at a first QKD station and a second interferometer loop at a second QKD station, comprising:
  - sending a control signal and a quantum signal from the first QKD station over the same path of the QKD system to the second QKD station, including over the first and second interferometer loops;
  - detecting first and second interfered control signals ICS1 and ICS2 at the second QKD station and calculating a ratio  $ICS1/ISC2$ ;
  - detecting first and second interfered quantum signals IQS1 and IQS2 at the second QKD station and finding an extremum of a ratio  $IQS1/IQS2$ ; and
  - adjusting a phase in an arm of the second interferometer loop based on a value of the ratio  $ICS1/ICS2$  corresponding to the extremum of the ratio  $IQS1/IQS2$ .
4. The method of claim 3, wherein the arm of the second interferometer includes a phase shifter driven by a voltage, and including dithering the voltage to maintain the ratio  $IQS1/IQS2$  as constant.

5. A method according to claim 3, wherein the quantum signal and the control signal have the same wavelength.
6. A method of stabilizing a QKD system, comprising:
  - sending a control signal and a quantum signal from a first QKD station to a second QKD station over the same optical path of an interferometer;
  - detecting first and second interfered control signals ICS1 and ICS2 at the second QKD station and calculating a ratio  $ICS1/ISC2$ ;
  - determining a value of the ratio  $ICS1/ICS2$  that corresponds to a maximum quantum signal count; and
  - adjusting a phase of the optical path to maintain said ratio value.
7. The method of claim 6, wherein adjusting the phase includes providing varying amounts of voltage to a phase shifter in a loop of the interferometer.
8. The method of claim 6, wherein the maximum quantum signal count is determined by a maximum of a ratio of interfered quantum signals detected at the second QKD station.
9. The method of claim 6, wherein the quantum signal has a first wavelength, the control signal has a second wavelength.
10. The method of claim 9, wherein the first and second wavelengths are the same.
11. A method of stabilizing a QKD system, comprising:
  - sending a control signal and a quantum signal from a first QKD station to a second QKD station over the same optical path of an interferometer;
  - using the control signal to determine a maximum count of the quantum signal; and
  - adjusting a phase of the optical path based on the control signal to maintain the maximum quantum signal count.
12. The method of claim 11, wherein adjusting the phase includes adjusting a voltage of a phase shifter in the optical path.